CCITT SGXV
Working Party XV/1
Specialists Group on Coding for Visual Telephony

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SOURCE: CHAIRMAN OF THE SPECIALISTS GROUP ON CODING FOR VISUAL TELEPHONY

TITLE: REPORT OF THE EIGHTH MEETING IN SAN JOSE (MARCH 10-13, 1987)

CONTENTS

1. General

The Specialists Group met in San Jose from March 10 to 13, 1987, at the kind invitation of Compression Labs, Inc., USA.

Before the session, Chairman introduced the following change of the core members.

USA:	from Mr. J.A. Bellisio	to Mr. H. Gharavi	(BELLCORE)
France:	from Mr. J.P. Temime	to Mr. G. Eude	(CNET)
Italy:	from Mr. A. D'Ottavio	to Mr. C. Gentile	(SIP)
UK:	from Mr. D. Bonnie	to Mr. N. Shilston	(GEC)

The list of participants appears at the end of this report.

At the final session, Chairman thanked the inviting organization for the meeting facilities provided and the excellent organization.

2. Documents for the Meeting

For this meeting, 35 normal documents and 12 temporary documents have been available. Annex 1 shows the outline of each document.

3. Video Source Coding

Along with the presentation of the documents, various demonstrations of simulation results as well as hardware processed pictures were also given. An overview of the tape demonstration is listed here.

a. Clipping effect and adaptive quantization for luminance and chrominance (Japan, #188)

b. Filter in the loop - 8x8 vs 10x10 and on/off control - (Japan, #189)
c. Two-dimensional VLC (Japan; #188)
d. Variable block size (Japan; #190)
e. Discarding of higher sequency components (Japan; #191)
f. Reference Model 3 (UK; #198)
g. Pre-filtering (UK; #199)
h. Full search motion estimation (UK; #202)
i. CIF + basic predictive loop hardware pictures (UK)
j. Reference Model 3 (NL; #198)
k. Adaptive quantization (NL; #206)
l. Loop filter - 8x8 vs 10x10 (NL; #205)
m. Post processing (NL; #207)
n. Variable block size - Variable/fixed block size, with/without MC (F; #210)

3.1 Reference Model 3 (#183, #186, #198)

Japan and Europe reported that several laboratories carried out the simulation on RM3 according to Annex 2 to Doc. #181R and Doc. #183, and obtained conforming data. Hence we can compare the results of the work done using RM3.

Members are encouraged to use the graphic method as in Doc. #198 for presenting the simulation results.

For future simulation experiments, Mr. Guichard coordinated a small group to define the Reference Model No. 4. Its specification and points on which to focus are described in Annex 2.

3.2 Quantization (#187, #206)

1) Threshold value

Doc. #187 reports that the optimum value of threshold is dependent upon the test sequence and 1.5xg is reasonable, while Doc. #206 reports that 1.0xg gives better performance than 1.5xg both objectively and subjectively. After some information exchange on the experimental data, it was agreed to use 1.0 xg for both the inter and intra modes in the initial compatibility check. It may, however, be further optimized through the future experiments.

2) Adaptive quantization

Experimental data, hardware implication and the time required for its implementation were considered. After some discussion, Mr. Booman undertook to coordinate a small group and obtained the following conclusion, which the meeting approved.

A small group consisting of members from UK, FRG, France, Japan, Netherlands has discussed Doc. #206 and Doc. #187. The principle of adaptive quantization as described in Doc. #187 and depicted in Fig. 1 below can be adopted. One of 32 quantizers may be assigned as a function of the sequency index, luminance/chrominance and intra/inter mode. This means that the quantizers and selection table are to be optimized in the flexible hardware.

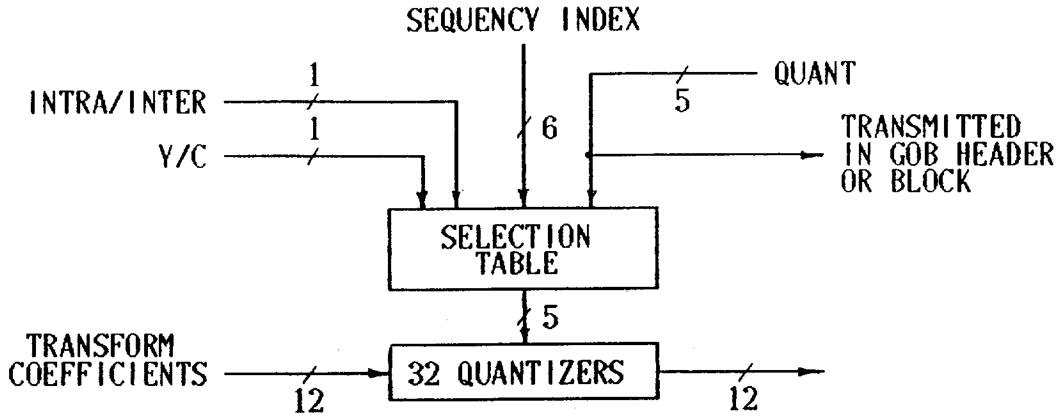


Figure 1 Adaptive quantizer structure

3) Intra DC quantization

The meeting agreed to use the step size of 4 for the intra DC quantization.

4) Clipping

Visual disturbance of clipping was presented in the tape demonstration related to Doc. #187. Mr. Guichard pointed out that if necessary, by changing the break-point between the variable length and fixed length parts in the code table, we can accommodate sufficient number of quantizer output levels to prevent clipping.

3.3 Loop filter (#189, #205)

1) 8x8 vs 10x10

Comparable numerical data as well as processed pictures were presented in the two documents. The meeting confirmed to leave the flexible hardware specification as it is with respect to this feature.

In the course of the discussion, Mr. Morrison made a comment that the effectiveness of loop filter might come from DCT being not the optimal transform for the MC prediction error.

2) Criterion to switch on the filter in RM3

An interesting fact was reported in Doc. #205 that the number of filtered blocks would strongly increase if the filter is adopted in case that 'the sum of the absolute filtered errors (D_f) is equal to or less than the sum of the absolute non-filtered error (D)'.

Mr. Kato made a comment that there will be two cases for D_f=D; one is the case where all pels have identical values on a pel by pel basis and the other is the case where only the sum has an identical value.

3) Filter control method

Side information control method and vector control method were compared. Since the simulation results show comparable performance in picture quality, both methods will be experimented in the flexible hardware by changing the code set for TYPE3 coding.

3.4 Variable block size (#191, #210)

Objective and subjective effects of the variable block size scheme were compared with those of the fixed block size scheme in the two documents. Since the improvements are recognizable, its hardware implication and the adoption in the flexible hardware were discussed. The conclusion is as follows:

Simulation results indicate that there is a subjective gain and at least one country plans to investigate the technique further by means of hardware implementation. However, since adoption of the technique would involve a significant modification of the flexible hardware specification, it will not be included.

The hardware tests should allow further study of the technique and provide more information, it will then be possible to compare the variable block size with other improvements obtained by means of optimization and less radical modifications before formulating the final Recommendation.

3.5 Non-compatibility items

The following items which are not relevant to the compatibility but can contribute to improving the performance were introduced.

- Temporal pre-filtering (#199)
- Discarding of higher sequency components (#190)
- Motion estimation (#202)
- Post-processing (#207)

The post-processing demonstration, in particular, showed that it is dramatically effective in reducing the coding noise, though the processed picture gives an artificial impression to some extent.

In the Q&A related to Doc. #190, a problem was recognized pertain to which strategy of sending lower sequency components more finely (suggested in Doc. #190) or sending more higher sequency components (suggested in Doc. #206) is better. Mr. Haskell made a comment that this should be evaluated in terms of subjective performance, but not in terms of r.m.s. error.

4. Video Multiplex Coding

4.1 VLC for transform coefficients (#188)

Simulation results on the coding efficiency of the two-dimensional coding were reported, which was carried out on the RM3. Though the improvement in terms of the number of saved bits is noticeable, its adoption in the Flexible Hardware specification is left for further study because of the time required to incorporate in the current hardware under construction. The initial compatibility check will be carried out using a one-dimensional VLC.

4.2 <u>TYPE3 and CLASS coding</u> (#184, #193, #204)

1) The meeting approved the proposal contained in Doc. #184 that BA and TYPE3 are not transmitted when all blocks in a GOB are intra coded or TYPE2=1xx.

2) The meeting took note of the fact TYPE2 is not necessarily utilized, leaving the relevant part of Flexible Hardware specification as it is.

3) Specific code words for TYPE3 and CLASS: see Section 6.

4.3 <u>Motion vector coding</u> (#192, #200, #201)

Coding efficiency of the differential motion vector was clarified. The differential vector is slightly better in efficiency than the absolute motion vector for normal videoconferencing scenes and much better for panning scenes. Since the current Flexible Hardware specification enables the experiment on both schemes, the meeting agreed to leave its relevant part as it is.

For the first mode of differential motion vector, Method 3 in Doc. #201 is applied modifying the modulo number to 32.

For specific code sets for the motion vector coding, see Section 6.

4.4 <u>Sync code detection</u> (#194)

Document #194 pointed out that there may occur emulation of PSC in Extra Information Insertion of Picture Header and in the intra DC component followed by AC components.

Through the discussion, it was clarified that when a switch occurs in MCU, MCU controls the timing so as to maintain a sufficiently long sequence of decodable but pictureless data before the PSC of the forced update picture. Those PSCs generated between the receipt of FUR and the forced update picture have different codes than other PSCs.

However, it was recognized that if extra information data exist in Picture Headers belonging to those pictureless data, then they may cause detection failure of the forced update picture. Solutions are for further study.

The proposal to cope with emulation of PSC in intra mode was accepted in principle and would be further examined together with specific code sets for all the transmitted elements in the video multiplex coding.

4.5 <u>Others</u>

The following two items were agreed upon.

1) m in PSPARE and GSPARE2.

For the initial compatibility check, the value of m is 1 for both of PSPARE and GSPARE2 when they are inserted by the control of PE1 or GE1.

Since the value of m may take different values for PSPARE and GSPARE2, the Flexible Hardware specification should use different notations, such as m and n respectively.

2) Priority between PGMV and GGMV.

GGMV overrides PGMV if both exist.

5. Transmission Coding

5.1 Video data buffering (#211)

Since video clock justification is not provided in the Flexible Hardware, overflows and underflows of the receiving buffer may occur from time to time.

Doc. #211 made a proposal to restrict the maximum coded picture frequency to cope with this problem with simple hardware.

During the discussion, it was pointed out that the other approach to use a decoder clock with a little higher frequency can also solve the problem.

Since this problem is relevant to hardware implementation, further examination on possible solutions is requested.

5.2 Application Channel Protocol (#195)

The meeting recognized Doc. #195 as a useful input toward formulating the final Recommendation. However, since we can carry out the initial compatibility check without Application Channel protocol, and since assigning the bits needs careful consideration on system aspects, further study is necessary. Contributions are encouraged.

For the initial compatibility check, the meeting agreed upon that Bits 17-40 should be set to zero (inactive).

5.3 Audio coding (#203)

The principle to split the compensating delay of the audio path in both encoder and decoder was supported. It was agreed as a working basis that the specification call for the delay of encoded audio relative to encoded video at the channel output of the n x 384 kbit/s coder to be within -35 ms to +70 ms when the encoder buffer is empty. Details are for further study.

5.4 One's density restriction (#215)

An example of the methods to cope with the one's density restriction was introduced, where the VLC code set proposed in Doc. #122 and #147 were modified with a marginal loss in coding efficiency. During the discussion, other methods such as used in H.120 or utilizing side information were also suggested. It was pointed out encryption and FEC aspects should also be examined.

As a conclusion, the meeting decided to continue the work according to the confirmation obtained in the Nürnberg meeting that 'we should deal with source coding and transmission coding separately, hence we would decide VLCs first and next consider the necessary measures to tackle with the one's density problem based on the statistical property of the codes generated'.

6. PROM Contents for Initial Compatibility Check

We need to set the PROM contents in the following programmable parts of the flexible hardware for the initial compatibility check:

a. Transformer
b. Classification
c. Quantizer
d. BA coding
e. TYPE3 coding
f. QUANT2 coding
g. CLASS coding
h. DMV coding
i. TCOEFF coding

Mr. Morrison was charged of coordinating concerned members on this matter and obtained the following results.

Since PROM contents are not necessary for hardware until just before the compatibility checks and these will not take place until September then this matter could be decided at the next Specialists Group meeting in June.

However for generation of test pattern by DIS, information is required more urgently. For the transformer, Doc. #142 Issue 2 is already suitable. For scanning sequences the four listed on page 22 of Doc. #181R are proposed. For all other VLC coded items, 2 VLC code sets will be used. They will be optimized for the two most commonly occurring data types. Other items will be coded with most appropriate of these two code sets. This activity will be done after the meeting and proposed sets will be issued for comments to the countries making hardware. Once agreed, information will be forwarded to DIS.

Remaining item is quantizers. One of 32 will be for INTRA DC component where some FLCs will be removed. Other quantizers will have dead zone of 1.0 g. Tables will be provided after the meeting by France/Netherlands.

7. Flexible Hardware Specification

Modifications to the existing specification in Doc. #182 are described in Annex 3, which reflect the agreements obtained during this meeting.

8. Intellectual Property (#185, #209, #212, #213, #214; TD4)

Information on relevant patents to the Flexible Hardware Specification and on the general patent licensing policy was provided by CSELT, PictTel, ALCATEL, SAT and NTA.

As a next action concerning the intellectual property, Chairman distributed a possible proforma (see Annex 4) for a formal statement on patent policy to be signed by participating organizations in the Specialists Group.

There was some discussion and a suggestion that existing documents (e.g. #176) already covered the spirit of Annex 4.

Annex 4 and signed document will be referred to the legal advisors of participating organizations for comment by the next meeting. The legality of such statements also needs consideration, for example, whether the laws of a particular nation needs to be cited.

9. Work Plan and Test Equipment (#208; TD3)

The three different methods were recognized to check compatibility among four flexible hardware under construction (FRG/Netherlands, France, Japan and UK);

- Check with the test equipment
- Back to back test
- Transmission test

It was informed that in Europe compatibility will be checked step by step through satellite circuits, without transporting the hardware.

For the test equipment, DIS reported a plan to provide such equipment using the VME approach, to which the following opinions were expressed.

- How can the test equipment be tested?
- It should provide a sufficiently long signal so as to enable waveform monitoring
- It may be better to start with very simple patterns.

Mr. Haskell coordinated a small group on the provision of the test equipment and obtained the following conclusion.

A group of interested parties met to discuss the possibilities and usefulness of bit-stream generators which would be used to verify the correct operation of decoders. The opinion was expressed that such bit streams should be repeatable, i.e., input continually into the receiver in such a way that a repetitive sequence of pixels results. It was ascertained that this would be possible, albeit with a coded frame rate slightly below 29.97 Hz, using a bit-stream of about 200 kBytes. Such equipment could be implemented using PROMS or EPROMS, depending on the desired number of test sequences and required flexibility.

Countries desiring test equipments are:

Japan (2)
U.K. (1)
Germany (1)
France (1)

10. m x 64 kbit/s (Annex 9 to Doc. #181R, #196, #197; TD5, TD8)

10.1 Frame structure

Doc. #196 pointed out such properties as;

- Synchronization of two 64 kbit/s channels
- Error correction codes, encryption and other requirements posed by coding algorithm
- Microprocessor implementation

may not be well handled with Y.221. In the discussion, there was an argument against it that Y.221 can meet these requirements. The meeting agreed to continue the study by listing up all the requirements to the frame structure for the m x 64 kbit/s video codec, and by checking whether or not Y.221 in its present state is applicable to each requirement. Views were also expressed that Y.221 is not yet in its final state.

10.2 Applications and their requirements on resolution

Three different categories with different resolution requirements were identified.

Category A: Still picture having CCIR Rec. 601 spatial resolution, which conveys a single-shot image.
Category B: Interactive graphics having at least CIF spatial resolution, which conveys moving images of drawing, sketching, coloring etc.
Category C: Face-to-face images to convey feeling of presence.

A common view is that the initial users will be business users.

For Categories B and C, the same codec is assumed to provide both resolutions as two operational modes. There were expressed the following three views on the philosophy to select the spatial resolution, or number of pels per picture:

- This parameter is not only related to performance, but also highly related to the equipment cost. Higher resolution may lead to unnecessarily expensive equipment. Such lower resolution as 256 elements x 240 lines is desirable.

- If the Recommendation will be made in the range of 3 years, we should open the door to more sophisticated technology to achieve resolution as high as possible.

- We can define a fundamental lower resolution together with an optional but specified higher resolution.

For specific values of the resolution related basic parameters, there were expressed strong supports to CIF on one side because of its worldwide compatibility and also compatibility with other services on one side, there was also expressed a concern about cost burden of standard conversion to CIF on the other side. There was also a suggestion that we should take a flexible approach to spatial and temporal resolutions, because performance requirements are not well defined.

10.3 Guidelines for future work

Since the proposals listed in Section 4 of Doc. #197 were considered to form a good basis for establishing the guidelines, they were reviewed item by item.

1) Simple relationship with CIF is essential.
2) Attempt should be made to aim at the spatial resolution of the CIF in order to allow a very good display for any kind.

For these two items, there were some discussions as described in Section 10.2 above. Further discussion is required.

3) Bit rate for the video signal, 64 kbit/s as reference, but also allow for shifting to 48 kbit/s down to 112 kbit/s up.

For this item, there were expressed two different opinions. One is to support the proposal because the ISDN basic service (2B+D) should be the first priority target. The other is not to support it because the lower end should be set as a goal for the video coding algorithm study as we did in case of nx384 kbit/s. Further discussion is required.

4) The signal delay caused by the codec should not exceed 250 ms.
5) A picture frequency of 10 Hz should generally not be lowered to maintain the lip-sync.
6) High resolution still picture transmission on 64 kbit/s should be done with separate algorithm (e.g.Q.18/VIII).

These three items were accepted as guidelines. Related to Item 5), transmission delay between two B channels was paid attention.

In addition to these six items, the meeting recognized necessity of the communication procedure study, which was raised in TD 5. It was noted that SG I and VIII are carrying out relevant study on the teleconferencing protocol.

10.4 Action points toward the next meeting

1) Collection of information on the state of the art

In order to get common understanding on the present state of the art on video coding for m x 64 kbit/s, the members were requested to provide information on the performance of the available hardware codecs or on simulation results, using the common digital test sequences Miss America and Trevor as far as possible. For this purpose, C format analog test sequence production was requested to the laboratories concerned.

2) Common test sequences

The meeting recognized the importance of having common videophone test sequences to study coding algorithms for m x 64 kbit/s. Proposals are requested.

3) Examinations toward establishing the framework of the codec

Contributions are requested on various items identified during this meeting and the previous one, particularly on those items dicussed in Section 9.1 - Section 9.3 above.

11. Next meeting

- Time: June 2(Tu) - 5(Fr), 1987
- Place: Stockholm
- Host: ELLEMTEL

Annexes

Annex 1: Documents for the San Jose meeting
Annex 2: Reference Model No.4
Annex 3: Modifications to Flexible Hardware specification
Annex 4: Intellectual property proforma

LIST OF PARTICIPANTS
(San Jose; March 10 - 13, 1987)

Chairman	S. Okubo	- NTT
Core Members		
F. R. of Germany	J. Speidel	- PKI
	G. Zedler	- FTZ
Canada	S. Sabri	- BNR
U.S.A	H. Gharavi	- Bell CORE
	B. G. Haskell	- AT&T Bell Labs
	R. A. Schaphorst	- DIS
France	G. Eude	- CNET
	J. Guichard	- CNET
Japan	Y. Kato	- NTT (acting for N. Mukawa)
	Y. Hatori	- KDD
Norway	G. Bjöntegaard	- Norwegian Telecom
Netherlands	F. Booman	- DNL
United Kingdom	R. Nicol	- BT
	N. Shilston	- GEC
Sweden	R. Campenhausen	- ELLEMTEL
	P. Weiss	- Swedish Telecom Admin.
Assisting Experts		
F. R. of Germany	W. Geuen	- FTZ-FI
U.S.A.	W. Chen	- CLI
	S. Ericsson	- PicTel Corp.
	M.L. Liou	- BELLCORE
	G. Pearson	- Video Communications
	K. Rao	- University of Texas at Arlington
	L. Rennick	- CLI
France	J. David	- Alcatel
	D. Devimeux	- SAT
Japan	T. Koga	- NEC
	K. Matsuda	- FUJITSU
United Kingdom	D.G. Morrison	- BT

Annex 1 Documents for the San Jose Meeting

Normal Documents

#181R REPORT OF THE SEVENTH MEETING IN NURNBERG (CHAIRMAN)

Points agreed upon and/or for further study are recorded on various aspects in order to provide backgrounds for the discussion in this meeting

#182 SPECIFICATION FOR THE FLEXIBLE PROTOTYPE n x 384 kbit/s VIDEO CODEC (CHAIRMAN)

This document is a revision of the Flexible Hardware Specification (Annex 4 to Doc. #140R) incorporating the additions and amendments agreed during the Nürnberg meeting in November 1986.

#184 SOME CLARIFICATIONS FOR RM3 (CHAIRMAN)

The following points were clarified for the Reference Model No. 3 which was defined in Annex 2 to Doc. #181R:

- Block type determination process
- Contents of the block attribute bits
- Scanning class determination method
- Data presentation format

#184 TRANSMITTED ELEMENTS WHEN ALL BLOCKS IN A GOB ARE INTRA CODED (CHAIRMAN)

It is proposed to omit both BA and TYPE3 in case of TYPE 2=1xx.

#185 STATEMENTS ON PATENTS ON 384 kbit/s PICTURE CODING FOR VISUAL TELEPHONY (CSELT)

General patent policy is stated to grant licenses on non exclusive, fair and reasonable terms, but on condition that the applicant first expresses willingness to do so.

#186 REFERENCE MODEL SIMULATION (NTT, KDD, NEC, FUJITSU)

Numerical data for the three test sequences are presented. It is also reported that the two criteria of determining the scanning class, one minimizing the number of zeros and the other minimizing the total bits for scanned coefficients, give the same class with 96 - 99% coincidence.

#187 ADAPTIVE QUANTIZATION (NTT, KDD, NEC, FUJITSU)

The following observations are presented:

- More than two quantizers are not necessary in a block.
- The optimum value of deadzone/stepsize is dependent on test sequences, and 1.5 is reasonable on the average.
- Color components could be quantized more coarsely than luminance ones.

- Clipping causes clearly perceptible impairments in still pictures, but not in motion pictures

As a conclusion, adoption of the modified quantizer selection in Flexible Hardware is suggested so that adaptive quantization can be studied using the hardware.

#188 CODING OF COEFFICIENTS QUANTIZATION INDEX WITH A TWO-DIMENSIONAL TABLE (NTT, KDD, NEC, FUJITSU)

A two dimensional coding table following the concept of Doc. #170 was tried on the RM3. Average bit saving is 950 bits/picture for the case EOB is represented by a fixed length code word, and 1300 bits/picture for the case EOB is variable length coded to show the number of non-zero coefficients in a block. SNR versus channel rate characteristics of RM3 is also reported.

#189 FILTER IN THE CODING LOOP (NTT, KDD, NEC, FUJITSU)

Several loop filter configurations are compared in the processing range, control method and filter application range. It is concluded as follows:

Processing range: Filter processing over block boundaries gives a little better performance with more hardware. The flexible hardware specification should be left as it is, still leaving the room for 10*10 to be included in the final recommendation.

Control method: Both of the side information control and motion vector control should be evaluated in the hardware experiments. An additional VLC code set for block type coding is proposed.

Filter application: Whether or not chrominance signals be filtered should be examined in the hardware experiments.

#190 DETERMINATION OF TRANSFORM COEFFICIENTS TO BE QUANTIZED - Part 2 - (NTT, KDD, NEC, FUJITSU)

Information is provided on the effectiveness of the thresholding before quantization. Two methods, one using rectangular zone, the other using scanning operation, give similar results.

#191 EFFECT OF VARIABLE BLOCK SIZE PROCESSING (NTT, KDD, NEC, FUJITSU)

Effectiveness of the variable block size scheme using 8*8, 8*4, 4*8 and 4*4 sub-blocks is reported together with possible hardware specification. This scheme is effective in reducing mosquito noise and block distortion. It is concluded that the variable block size scheme be included in the flexible hardware as an additional core element.

#192 CODING OF MOTION VECTOR INFORMATION (NTT, KDD, NEC, FUJITSU)

Comparison results between the two motion vector coding methods, absolute and relative, are given on coding efficiency for the three test sequences as well as the two panning sequences. Influence of the folding over of the relative vectors is also discussed. It is concluded that the relative method gives slightly better performance even for the normal scenes. A VLC set is proposed for the initial test of the flexible hardware.

#193 CODING OF BLOCK TYPE (NTT, KDD, NEC, FUJITSU)

Block type statistics based on the Flexible Hardware specification (Section 2.2.3/Doc. #182) are presented. Since 87% of all the GOBs belong to TYPE2=011, two code sets, one for luminance and the other for chrominance, are proposed. It is also pointed out that this coding saves about 1000 bits per picture compared to the RM3 bit count method for the block attributes.

#194 PSEUDOSYNC CODE (NTT, KDD, NEC, FUJITSU)

Emulation of PSC (15 consecutive zeros followed by one) can occur in Extra Information in Picture Header and TCOEFF in intra coded blocks. For the former, appropriate operation of MCU or coder should be kept to ensure the detection of the fast-updated picture. For the latter, some restriction to the code words for the DC components is proposed.

#195 BIT ASSIGNMENT FOR APPLICATION CHANNEL (NTT, KDD, NEC, FUJITSU)

This document first proposes a method to deal with essential and optional facilities by using facility and operational mode indication, then lists up the control & indication signals to be transmitted using the bit protocol through the Application Channel, and finally proposes a bit assignment of those control & indication signals to the 24 bits in the Application Channel.

#196 FRAME STRUCTURE FOR m x 64 kbit/s VIDEO TELEPHONY (USA)

A question is raised on the applicability of Y.221 to videophone services. The followings are pointed out as missing from Y.221.

- Synchronization of two 64 kbit/s channels for the 2B+D interface.
- Particular requirements posed by video coding algorithms, error correction codes, and encryption.
- Byte-oriented structure to facilitate a microprocessor implementation.

#197 DISCUSSION PAPER ON SUMMARY REPORT ON THE m x 64 kbit/s VIDEO-PHONE CODEC (FRG)

From some requirements for an acceptable service on 64 kbit/s picture phone codec, the followings are proposed:

- The signal delay caused by the codec should not exceed 250 ms.
- Simple relationship with CIF is essential.
- High resolution still picture transmission on 64 kbit/s should be done with separate algorithm.
- Bit rate for the video signal is 64 kbit/s as reference, but allowance for shifting down to 48 kbit/s and up to 112 kbit/s is provided.

- Attempt should be made to aim at the spatial resolution of the CIF in order to allow a very good display for any kind of graphics.
- A picture frequency of 10 Hz should generally not be lowered.

#198 RM3 STATISTICS (UK, NL, FR, D)

Numerical and graphic data are presented for the three test sequences.

#199 TEMPORAL PRE-FILTERING APPLIED TO THE REFERENCE MODEL 3 (UK)

Temporal noise reduction pre-filtering of the source material is shown to significantly improve overall coding results, particularly in reduction of the average quantizer step size.

#200 DIFFERENTIAL MOTION VECTORS 1 (UK)
#201 DIFFERENTIAL MOTION VECTORS 2 (UK)

The merits of using a differential motion vector scheme within the RM3 are examined. After having compared three differential motion vector coding methods to fold the difference by using the knowledge that any absolute vector must be in the tracking range. The differential method gives slightly better coding efficiency, but suffers from error propagation. Robustness of differential vector coding is also confirmed. It is concluded that the current Flexible Hardware specification should be left as it is in order to investigate both of absolute and relative methods in hardware experiments.

#202 MOTION ESTIMATION ALGORITHMS (UK)

A full search motion estimation is compared with the three stage reference method. It produces superior results objectively and subjectively.

#203 AUDIO DELAY IN n*384 kbit/s CODEC (UK)

Since the permissible delays of sound with reference to vision are stipulated as +140 ms to -70 ms in CCIR Report 412-3, it is suggested that the specification provisionally call for the relative delay between encoded audio and encoded video at the channel output of the n*384 kbit/s coder to be within half of the above figures when the encoder buffer is empty. Further study is necessary on the following points:

- Minimizing the total round trip delay time
- Lip sync
- Effect of picture dropping

#204 VLC OPTIMIZATION FOR BLOCK TYPES (NL, UK, F, FRG, S)

Statistics for the block type which integrates filtering indication with inter/intra, coded/non-coded and MC/No-MC attributes are presented. The word length of the VLCs for luminance and chrominance blocks is proposed. Statistics and the VLC word length for the scanning class are also given. A question is raised whether to use the VLC optimized for the most critical scene or to apply a sub-optimal VLC based on an average over several sequences.

#205 FILTERING INSIDE AND OVER THE BLOCK BOUNDARIES (NL, UK, F, S)

Both configurations are compared in performance on the RM3. The filter over the block boundaries gives a small gain objectively, but shows a similar performance subjectively to the filter inside the block boundaries. Hence it is proposed that the decision should be made on hardware grounds.

#206 QUANTIZATION WITH DIFFERENT THRESHOLDS (NL, UK, F)

After having compared two quantizer threshold values, 1*g and 1.5*g, the former is concluded to be better in the objective and subjective performance. Hence it is proposed to adopt a threshold of 1*g instead of 1.5*g. An observation is made that only the first step of the quantizer is important to determine the mean value of the step size in the closed loop simulation.

#207 POST PROCESSING (NL)

Two post processing algorithms, a filter based on a minimum variance algorithm and a filter which applies a linear least square error algorithm, have been examined. They give significant objective and subjective improvements. A question is raised whether or not we are focussing too much on saving a few bits at the cost of greatly increased complexity in the source coding and the video multiplex coding.

#208 A SIGNAL GENERATOR TO TEST n x 384 kbps DECODERS (DIS)

Progress is reported on the signal generator development to provide serial bit streams for testing decoders. Key characteristics of the equipment, schedule, price etc. are informed.

#209 PATENT APPLICATION ON ADAPTIVE FILTERING (PICTEL)

It is informed that a US patent application was filed on the adaptive loop filter controlled by sending the side information. A general patent policy of PicTel is stated to be 'granting licenses on a non-discriminatory, reasonable and fair terms basis if the applicant is prepared to do so'.

#210 VARIABLE BLOCKSIZE CODING ON THE REFERENCE MODEL NO. 3 (FRANCE)

A variable block size scheme using one 8*8 and four 8*4 sub-blocks has been compared with an improved reference model. Objectively, it provides better performance in SNR only in Checked Jacket. Subjectively, however, it provides better picture in sharpness. It is concluded not to suggest the inclusion of the variable block size scheme in the first flexible hardware prototype.

#211 SYNCHRONIZATION AT THE RECEIVER (FRANCE)

A restriction of the maximum coded picture frequency to 29.97 Hz is proposed for the flexible hardware with defining 'minimum temporal subsampling rate' of e.g. 1/100. This method enables to avoid buffer overflows and underflows at the receiver with simple hardware. Overflows can be prevented by omitting the subsampled picture if necessary, and underflows can be prevented by repeating the previous coded picture if necessary.

#212 PATENTS (ALCATEL CIT)
#213 POSITION OF SAT REGARDING PATENTS (FRANCE)

General patent licensing policies are stated.

#214 POSITION OF THE NORWEGIAN TELECOMMUNICATION ADMINISTRATION (NTA) ON PATENTS (NORWAY)

Information on relevant patents to the Flexible Hardware specification and general patent licensing policy is stated.

#215 EFFECTS OF DS1 CONSTRAINTS ON VLC DESIGN (BELLCORE)

The issue of the DS1 constraints regarding the n x 384 kbit/s videoconference is addressed. Conditions for the design of VLCs are discussed to be that no word should contain all zeroes and no combination of words will have more than eight consecutive zeroes. An example of VLC set is given which meets DS1 constraints without significantly affecting the bit rate.

Temporary Documents

No. 1 Agenda (Chairman)
No. 2 Available documents (Chairman)
No. 3 Plan toward making Recommendations on n x 384 kbit/s codec (Chairman)
No. 3 Hardware trials (Chairman)
No. 4 Statement on patent licensing policy (Chairman)
No. 5 Communication procedure study for m x 64 kbit/s terminal (Chairman)
No. 6 Discussion results (Small group on quantizer)
No. 7 Conclusion on variable block size discussion (Chairman)
No. 8 Videophone service study (Switzerland, FRG, UK)
No. 9 List of participants (Secretariat)
No. 10 Generation of test bit-streams (Small group on test equipment)
No. 11 RM4 and some points on which to focus (Small group on RM4)
No. 12 Draft report of the eighth meeting in San Jose (March 10-13, 1987) (Chairman)

Annex 2 RM4 and some points on which to focus

I. Reference Model No. 4

The reference model no. 3 has been modified as follows:

1) The threshold of the quantizer is now:

   T = g instead of T = 1.5 g

2) A 2D-VLC combined with the four scanning classes is introduced. The procedure is:

   * First determine the best class by minimizing the address of the last non-zero coefficient (as in RM3).

   * Consider an event (E) as a run of zeroes (R) followed by a non zero coefficient (L).

     E = (R,L)

   * Apply Table 1 (corresponding to method 1 in Doc. #188). Note that now the length of the EOB word is two, and that some modifications have been introduced concerning the escape code (6 bits), the number of bits for the value of the non-zero coefficients (8 bits) which is called LEVEL in Doc. #188 and the number of bits for the runs of zeroes (6 bits).

     The maximum value for the non-zero coefficients is now

     +127 g and -128 g.

     The code set table is attached as Appendix.

3) A new VLC for the block attributes is introduced.

   The relative addressing technique is now applied to the "non-modified" blocks defined as: Inter/no MC/no Fil/not coded (The VLC is the same as RM3).

   The new VLC for the block attributes is shown in Table 2.

II. Points on which to focus

1) Adaptive quantization with respect to Section 3.2 2) of this report.

2) Optimization of the 2D-VLC code set table

3) Sensitivity to error of RM4

Table 1 Word Length of VLC for Two-dimensional Coding

LEVEL (absolute value)

RUN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20 . .128
0	3	5	6	8	9	9	11	13	13	13	13	14	14	14	14	20	20	20	20	20
1	4	7	9	11	13	14	14	20	20	20	20	20	20	20	20	20	20	20	20	20
2	5	8	11	13	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
3	6	9	13	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
4	6	11	13	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
5	7	11	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
6	7	13	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
7	7	13	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
8	8	13	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
9	8	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
10	9	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
11	9	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
12	9	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
13	9	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
14	11	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
15	11	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
16	11	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
17	13	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
18	13	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
19	13	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
20	13	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
21	13	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
22	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
23	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
24	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
25	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
26	14	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
27	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
28	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
.																				
.																				
63																				

** Word lengths of all other EVENTs (combination of RUN and LEVEL) are 20: ESCAPE CODE(6bits)+RUN(6BITS)+LEVEL(8bits).

** Word length of EOB is 2.

Table 2 VLC for block the attributes in RM4

Y-MODES				LENGTH
	Coded	MC	Filt	
INTRA	-	-	-	4
FILTERED FIXED	F	F	T	3
NON-FILT FIXED MC	F	T	F	4
FILTERED FIXED MC	F	T	T	4
NON-FILT INTER	T	F	F	2
FILTERED INTER	T	F	T	4
NON-FILT INTER MC	T	T	F	3
FILTERED INTER MC	T	T	T	2

C-MODES			LENGTH
	Coded	Filt	
INTRA	-	-	3
FILTERED FIXED	F	T	3
NON-FILT INTER	T	F	1
FILTERED INTER	T	T	2

Appendix Code Set for Two-dimensional Coding of Coefficient Quantization Index (RM4)

No	RUN	LEVEL	CODE LENGTH	CODE	CODE STRUCTURE
1	0	-1	3	111	VLC
2	0	1	3	110	
3	1	-1	4	1011	VLC
4	1	1	4	1010	
5	2	-1	5	10011	VLC
6	2	1	5	10010	
7	0	-2	5	10001	
8	0	2	5	10000	
9	3	-1	6	001111	VLC
10	3	1	6	001110	
11	4	-1	6	001101	
2	4	1	6	001100	
3	0	-3	6	001011	
4	0	3	6	001010	
5	5	-1	7	0001111	VLC (4bits) + FLC (3bits)
6	5	1	7	.	
7	1	-2	7	.	
8	1	2	7	.	
9	6	-1	7	.	
20	6	1	7	.	
1	7	-1	7	.	
2	7	1	7	0001000	
3	8	-1	8	00001111	VLC (5bits + FLC (3bits
4	8	1	8	.	
5	0	-4	8	.	
6	0	4	8	.	
7	9	-1	8	.	
8	9	1	8	.	
9	2	-2	8	.	
30	2	2	8	00001000	
31	10	-1	9	001001111	VLC (6bits + FLC (3bits
2	10	1	9	.	
3	0	-5	9	.	
4	0	5	9	.	
5	1	-3	9	.	
6	1	3	9	.	
7	3	-2	9	.	
8	3	2	9	001001000	
9	11	-1	9	000001111	VLC (6bits + FLC (3bits
40	11	1	9	.	
1	12	-1	9	.	
2	12	1	9	.	
3	0	-6	9	.	
4	0	6	9	.	
5	13	-1	9	.	
6	13	1	9	0000010000	

No	RUN	LEVEL	CODE LENGTH	CODE	CODE STRUCTURE
47	4	-2	11	00000011111	
8	4	2	11	.	
9	14	-1	11	.	
50	14	1	11	.	
1	15	-1	11	.	
2	15	1	11	.	VLC (7bits)
3	1	-4	11	.	
4	1	4	11	.	+
5	2	-3	11	.	
6	2	3	11	.	FLC (4bits)
7	0	-7	11	.	
8	0	7	11	.	
9	5	-2	11	.	
60	5	2	11	.	
1	16	-1	11	.	
2	16	1	11	00000010000	
3	17	-1	13	0000000111111	
4	17	1	13	.	
5	6	-2	13	.	
6	6	2	13	.	
7	0	-8	13	.	
8	0	8	13	.	
9	3	-3	13	.	
70	3	3	13	.	
1	1	-5	13	.	
2	1	5	13	.	
3	18	-1	13	.	VLC (8bits)
4	18	1	13	.	
5	19	-1	13	.	+
6	19	1	13	.	
7	0	-9	13	.	FLC (5bits)
8	0	9	13	.	
9	20	-1	13	.	
80	20	1	13	.	
1	21	-1	13	.	
2	21	1	13	.	
3	7	-2	13	.	
4	7	2	13	.	
5	2	-4	13	.	
6	2	4	13	.	
7	0	-10	13	.	
8	0	10	13	.	
9	4	-3	13	.	
90	4	3	13	.	
1	8	-2	13	.	
2	8	2	13	.	
3	0	-11	13	.	
4	0	11	13	0000000100000	

No	RUN	LEVEL	CODE LENGTH	CODE	CODE STRUCTURE
95	22	-1	14	00000000111111	
6	22	1	14	.	
7	23	-1	14	.	
8	23	1	14	.	
9	24	-1	14	.	
100	24	1	14	.	
1	25	-1	14	.	
2	25	1	14	.	
3	26	-1	14	.	
4	26	1	14	.	
5	0	-12	14	.	
6	0	12	14	.	
7	0	-13	14	.	VLC (9bits)
8	0	13	14	.	
9	0	-14	14	.	+
110	0	14	14	.	
1	0	-15	14	.	FLC (5bits)
2	0	15	14	.	
3	1	-6	14	.	
4	1	6	14	.	
5	1	-7	14	.	
6	1	7	14	.	
7	2	-5	14	.	
8	2	5	14	.	
9	3	-4	14	.	
120	3	4	14	.	
1	5	-3	14	.	
2	5	3	14	.	
3	9	-2	14	.	
4	9	2	14	.	
5	10	-2	14	.	
6	10	2	14	00000000100000	
127	EOB WORD		2	01	VLC
128	ESCAPE CODE		6	001000	VLC

** Other EVENTs (combination of RUN and LEVEL) are coded to:
ESCAPE CODE(6bits)+RUN(6bits)+LEVEL(8bits)

Annex 3 UPDATE OF FLEXIBLE HARDWARE SPECIFICATION

This document covers the changes to the Flexible Hardware Specification agreed at the eighth meeting of the Specialists Group in March 1987.

This document should be used in conjunction with Doc. #182 and section numbers refer to it.

Generally, all code sets and tables referring to programmable elements are removed. Default values for use in the initial compatibility checks are given in Doc. #217.

1.2.2 The note referring to the encoding method for motion vectors is removed.

1.2.6 Quantizer

Replace existing text with:

"The number of inverse quantizers in the decoder shall be 32, each of which is programmable and has up to 12 bits input and 12 bits out. One of the 32 characteristics may be assigned as a function of quantizer indicator (QZ of Figure 4), sequency index, luminance/chrominance block and intra/inter mode. See Figure 10. Quantizer characteristics and selection function table are for further study."

2.2.1 Picture Header

In Figure 5, the sizing arrows and text "nx8 bits" are removed to avoid conflict with nx8 in GSPARE2 (see below). The point is adequately covered in the note under Figure 5.

2.2.2 Group of Blocks Header

In Figure 7, the length of GSPARE2 is changed to nx8 bits.

In Figure 7, the sizing arrows and text "nx8 bits" are removed to avoid conflict with nx8 in GSPARE2. The point is adequately covered in the note under Figure 7.

Group of Blocks Global Motion Vector

The note about priority between PGMV and GGMV is removed. The issue is dealt with in 2.2.3 under Motion Vector Information.

2.2.3 Block Data Alignment

The note regarding Figure 8 is replaced by the following:

"Note: Data are coded using VLC(s) which require further study. Some of the elements are omitted when not required. Future study may change the order and coding of the elements."

Block Address (BA)

Insert new paragraph after the first one:

"When all blocks in a GOB are coded in intra mode (TYPE2='1xx'), BA is not transmitted for those blocks."

Block Type Information (TYPE3)

Insert after the seven types of block a one line paragraph:

"When all blocks in a GOB are coded in intra mode (TYPE2='1xx'), TYPE3 is not transmitted for those blocks."

Insert after the first sentence in the paragraph between Table 2 and Table 3:

"The code set(s) is (are) for further study."

Quantizer Type (QUANT2)

Delete all except the last sentence. Replace with:

"The five bits of the quantizer indicator (QZ) input to the quantizer selection table. QZ_4 first, QZ_0 last."

Motion Vector Information (DMV)

The sentences and equation "In the second mode the difference vector .... in two's complement notation." are replaced by:

"In the second mode the difference vector is obtained from the motion vector of the block being transmitted and the current global vector.

$$dv(B_n) = v(B_n) - v(G)$$

where $dv(B_n)$ and $v(B_n)$ are as defined above,

$V(G)$ = GGMV if present in the Header of this GOB, else PGMV if present in the Header of this Picture, else zero.

In both modes the absolute vectors are as defined in Section 1.2.2 and the difference is also represented in two's complement notation, but only the five LSBs are retained for subsequent encoding."

Transform Coefficient Data (TCOEFF)

The note regarding the code set is replaced by the sentence:

"The code set is for further study."

Insert an additional sentence between the existing two in the penultimate paragraph:

"The code set is for further study."

3.2 Framing Structure

Delete "(To be specified - see Annex 7 to Doc. #181R)". Replace with:

"For further study. Application Channel (bits 17 to 80 of Figure 9) to be set to '0' until agreed otherwise."

3.6 Audio

Delete last sentence. Add:

"Delay of encoded audio relative to encoded video at the channel output provisionally within -35ms to +70ms when the encoder buffer is empty."

Fig. 4 (amended) includes intra/inter switching.

New Figure 10 concerning quantizer selection table is added.

End.

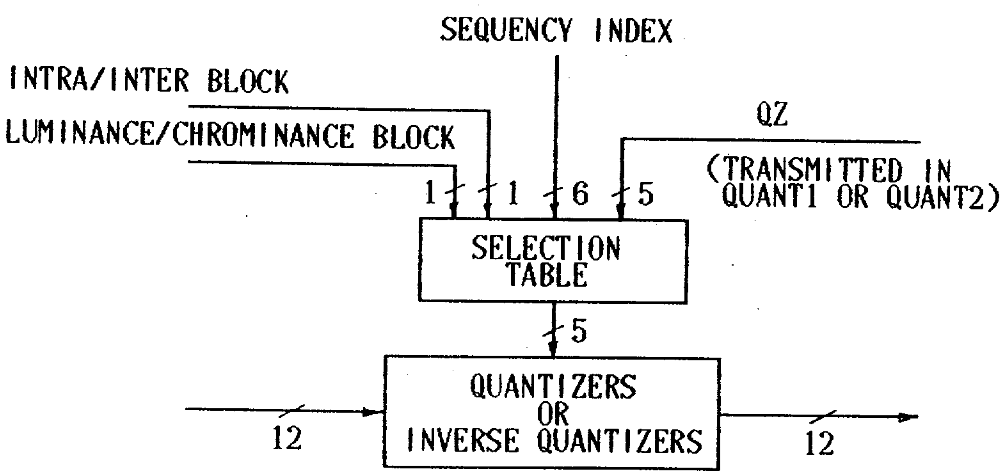
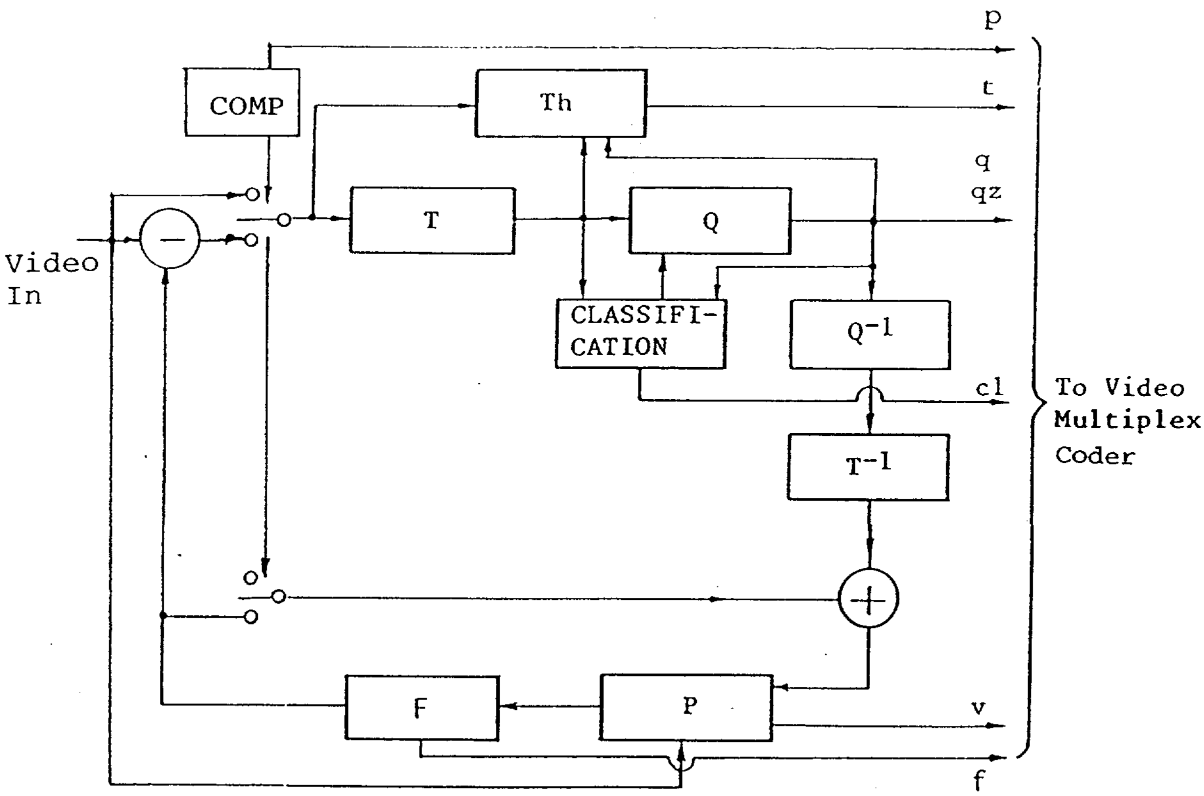


Fig. 10



COMP Comparator for intra/inter
Th Threshold
T Transform
Q Quantizer
P Picture memory with motion compensated variable delay
F Loop filter

p Flag for intra/inter
t Flag for transmitted or not
q Quantizing index for transform coefficietns
qz Quantizer indication
v Motion vector
cl Classification index
f Switching on/off of the loop filter

Fig. 4 (amended)

Annex 4 Intellectual property proforma

Subject: Statement on patents on the n x 384 kbit/s video coding for visual telephony

X will, upon adoption of such Recommendation by CCITT, grant licenses under its patents on a non-exclusive basis and on non-discriminatory fair and reasonable terms to all users solely for their use in complying with the Recommendation, but on a condition that any such user first express willingness to grant to X, for itself and its subsidiaries, similar licenses under such user's patents, if any, for use in complying with the Recommendation.

The grant by X will be for licenses to make, have made, use, sell, lease and import any equipment complying with the Recommendation.

As used herein,

"Patents" means patents for inventions made prior to the adoption of the Recommendation which patents are owned or controlled by the grantor (X or the user) or its subsidiaries; provided, however, that in no event will any licenses granted pursuant to this commitment include licenses under any patent the use of which is not essential to meeting the Recommendation or which can be avoided by those skilled in the art through the exercise of their best efforts.

"Recommendation" means a recommendation by the CCITT for a preferred algorithm for the n x 384 kbit/s video coding for visual telephony.

"Subsidiary" means any corporation, company or other entity more than fifty percent of whose voting shares or outstanding capital stock is owned or controlled directly or indirectly by X.